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ABSTRACT

During the fall semester of 1993, a curriculum-based computer-based training (CBT) program was used to replace all in-class drills in intervals and chord identification for one section of freshman music theory at the University of Northern Colorado. This study was conducted to determine whether aural skills can be taught as effectively through the exclusive use of a curriculum-oriented, computer-based tutorial and drill program, as when taught by traditional in-class diction drills coupled with the optional use of commercial software, and to determine the effects of such a method upon the attitudes of music students. A control (n=20) and experimental (n=16) group each received the departmental placement exam and final exam for ear training, which functioned as the pretest and posttest, respectively. The comparison with a section using commercial software as an optional supplement to traditional in-class drill found no significant difference in achievement or attitude. However, results indicate the computer provided more efficient and consistent instruction. There was also a significant difference in the amount of time spent outside of class on ear training and in the amount of improvement attributed to the use of CBT. Five tables summarize study data. (Contains 10 references.) (Author/MAS)

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Strategies for Integrating Computer-Based Training in College Music Theory Courses

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Abstract: During the fall semester of 1993, a curriculum-based CBT program was used to replace all in-class drill in intervals and chord identification for one section of freshman music theory at the University of Northern Colorado. A comparison with a section using commercial software as an optional supplement to traditional in-class drill found no significant difference in achievement or attitude. However, the results indicate the computer provided more efficient and consistent instruction. There was also a significant difference in the amount of time spent outside of class on ear training and in the amount of improvement attributed to the use of CBT.

It is difficult to imagine a prerequisite for serious music study more important than the ability to hear and identify musical sounds accurately. Indeed, virtually all music schools incorporate some sort of aural training in their lower division curriculum, most often in the form of sight-singing and dictation classes (Pembrook & Riggins, 1990). The problem is that, due to disparate abilities and rates of learning, peer-pressure, delayed and ineffective feedback and the lack of class time available, aural skills are most efficiently and effectively acquired through private, individualized instruction.

It was proposed that computer-assisted instruction had the potential for solving the needs of many students. In the twenty-five years since research in computer-assisted ear training instruction began, numerous studies have compared computer-based instruction with traditional in-class drill or pre-recorded programmed instruction. Among the reported benefits were (a) better performance on ear training tests, (b) better long-term retention of aural discrimination skills, and (c) improved attitude towards ear training and computer-assisted instruction. These benefits were primarily attributed to the computer's ability to provide individualized instruction and immediate evaluation and feedback. (Allvin, 1971; Benward, 1987; Hofstetter, 1981).

Purpose

Computer-assisted ear training instruction has been shown to be effective in numerous studies during the 1970's and 1980's (Hofstetter, 1975; Humphries, 1980). In many of those studies, courseware was specifically developed to support their respective curricula and its use required. In contrast, since the development of the microcomputer, most music theory courses have relied on the voluntary use of generalized, commercial software to provide computer-assisted drill (Pembrook, 1990). The intent of this study was to determine if a required, curriculum-specific, computer-based ear training program could be used as an effective substitute for in-class drill, individual practice and the optional use of commercial software. Additionally, it was expected that information would be obtained regarding the effectiveness of the courseware used in the study. A secondary purpose was to determine whether attitudes toward ear training and computers were affected by the different methods.

In the course of the study the specific questions that were to be investigated are: How does each method affect student progress and performance? How does each method affect the amount of time spent outside of class practicing ear training and the effect on the student perception thereof? How does each method affect students attitudes towards ear training and computer-assisted instruction? What are the effects on students attitudes when

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CAI is required as opposed to voluntary? What is the relationship between scores on practice drills and examinations? What additional benefits and drawbacks are perceived by the students in regards to each method?

CAI Program Design

A computer-based learning system was developed by the researcher to correspond with the University of Northern Colorado music theory curriculum. Based on discussions with the music theory faculty, five subject areas were selected to be included included in the software--Intervals; Tone Rows; Soprano, Chord Type & Bass; Chord Qualities; and Diatonic Progressions--with each subject being presented in three ways. The *Lessons* present concepts and identification strategies from as many viewpoints as possible. Students are encouraged to interact with the program in a variety of ways and the lessons provide stimulus in the three modes of learning: auditory, visual and kinetic. Interspersed throughout the tutorials are open-ended, ungraded, guided *Practice Sessions*, which are also accessible directly from a submenu. The *Drills* have from three to five levels with preset contents and an option to customize the exercises. Upon completion of a drill, the percentage of correct answers is calculated and displayed with a suggested path for further study.

The program stores thorough records regarding student activity and progress. Students must be registered to use the program. When students first complete the registration process, a new personal records file is created on the file server. Upon the completion of each practice exercise or drill, the program opens the student's record file and records information about the current session. Depending on the type of instruction, the stored information may include the name of the lesson, the time spent in the section, the number of questions, the percentage of correct responses and the number of replays per exercise. Upon electing to exit the program, a summary of the total number of exercises and the average score is shown.

Navigation is accomplished through a series of menus and submenus. Structure within the tutorial and exercise sections is primarily linear, with some optional branching for additional information. The structure of the drills is more independent, with each drill accessible only from its respective submenu. Students may exit at any time. The sound is MIDI-based and students are encouraged to select a sound with which they are comfortable.

While research indicates that total learner control results in the least improvement (Steinberg, 1977), it was also noted that the control maintained by competency-based programs increased student frustration (Hofstetter, 1975). The compromise chosen, based on Tennyson's model (1981), was to allow learner control with advisement. Students may select any section of the program at any time; there are no prerequisites. The program provides advice as to the suggested course of study and also influences decisions by limiting choices and through screen design.

Procedures

The study was conducted during a ten-week period of the Fall 1993 semester in the University of Northern Colorado School of Music. One section of the freshman music theory class, "MUS 101-Sight Singing and Music Theory" was selected as the experimental group, with another functioning as the control group. All freshman music theory sections follow approximately the same syllabus and administer the same exams.

Students in the experimental group received all instruction and drill related to harmonic dictation and intervals through the use of the computer-assisted instruction programs developed for this class. The students were instructed in the use of the software during one regular class session. During weeks six through fifteen, students in this group were required to spend a minimum of two hours per week on the programs, unless they earned three scores of 90% or above on the highest level for each subject. The use of the program was averaged as part of the homework and quiz grade which accounts for 20% of the final grade. Students using the program an average of 2 hours per week or successfully completing all levels received a grade of 100; each minute below 120 per week resulted in a one point reduction. Quizzes and examinations took place as usual and included dictation examples.

The control group received traditional instruction, which consists of classroom drill and practice outside of class. Voluntary use of commercial, computer-assisted ear training software was encouraged, however, access to the curriculum-based software was restricted.

Because random selection of the subjects was not possible, a quasi-experimental pretest-posttest, control group design using intact groups was chosen. Of the five existing sections of freshman music theory, one was selected as the experimental group and a second as the control group. All students take a departmental placement test on the second class meeting; this was used as the pretest. The final ear training examination for the course was used as the posttest. The design is represented in Figure 1, with 0_1 to 0_4 representing the pretest and posttest scores, T representing the regular classroom instruction with voluntary use of commercial computer-assisted instruction programs and TX representing the regular classroom instruction with curriculum-based computer-assisted instruction replacing in-class drill.

Group	n	Pretest	Treatment	Posttest
I	23	0_1	T	0_2
II	19	0_3	TX	0_4

Figure 1. Experimental design

The treatment was administered in the University of Northern Colorado Music Technology Center. Students were allowed to choose the time and length of sessions. Availability and convenience was not a consideration as the Computer/Synthesis Lab is available seventy-five hours per week. The lab consists of 31 workstations with Macintosh SE/30 computers and Kawai K-4 or K-11 synthesizers.

A Likert-type, attitude instrument, developed by the researcher was administered to both groups before and after the treatment period. The purpose was to determine if the treatment had any effect upon the attitudes of the subjects toward ear training or computers, and to see how effort was affected.

A test was also administered to determine if any of the subjects possessed perfect pitch. Students were asked to identify eight pitches played on the piano by the researcher. As a result, two students who were found to have perfect pitch in the control group were excluded from the study.

An audit trail was maintained by the computer-assisted ear training software used by the experimental group. Information regarding student progress, time per exercise, total time per session, exercises attempted, number of questions attempted and number of replays required was recorded.

Limitations

Experimental mortality occurred in both groups with three students in each group dropping the class and not taking the final exam, leaving 16 students in the experimental group and 20 students in the control group.

Intrasession history may have affected the results. On a number of occasions, students in the experimental group reported malfunctions in the program. In general, these errors had to do with the storing of records and were not sufficient to affect aural skills development, but may have had an effect upon students' attitudes.

While the synthesizers used have a fair representation of an acoustic piano, the timbral difference between the synthesizer and the piano may also have had an effect on exam performance. Students in the experimental group practiced using timbres found on the synthesizer, but the exam was performed on a piano.

Data Analysis

The study was conducted to determine whether aural skills can be taught as effectively through the exclusive use of a curriculum-oriented, computer-based tutorial and drill program, as when taught by traditional in-class dictation drills coupled with the optional use of commercial software, and to determine the effects of such a method upon the attitudes of music students. A control and an experimental group each received the departmental placement exam and final exam for ear training, which functioned as pretest and posttest, respectively. The two groups received identical tests.

To determine which method provided the greatest improvement in aural discrimination skills, an analysis of covariance (ANCOVA) was performed to equate the groups and compare performance statistically, with the pretest as the covariate and the posttest as dependent variable. Table 1 shows that scores of both groups final ear training examinations were statistically equivalent. While no difference was found between the adjusted means, a

decrease of over 30% from pretest to posttest was noted in the variance and standard deviation for the experimental group. At the same time, those measures increased 10% for the control group.

Table 1
Analysis of Covariance

Source	Sum-of-the-Squares	DF	Mean-Square	*F*-Ratio	*p*
Group	0.026	1	0.026	0.000	0.989
Pretest	812.012	1	812.012	5.650	0.023
Error	4742.876	33	143.724		

A comparison of the overall final grades of both groups using a *t* test was made to determine whether the additional time in class made available to the experimental group due to the treatment had an effect. The experimental group's mean final grade was slightly higher than the control group's, but the difference was not significant.

Data was sought regarding the attitudes of the students and the effect the treatment had on those attitudes regarding ear training, computer-assisted instruction, self perception of aural discrimination skills ability ,and expected success Seven questions were each asked of both groups before and after the treatment. The questions are listed in Figure 2.

1. How would you describe your attitude towards ear training study?
2. How would you rate your abilities in ear training?
3. How important (relevant) is ear training to you?
4. What is your attitude towards computers in general?
5. Please rate your knowledge of computers.
6. How do you feel about using computers to replace some in-class instruction?
7. How well do you expect to do in the ear training part of this class?

Figure 2. Attitude Instrument Questions

Students were asked to rate their answers on a five-point Likert scale. A *t* test was performed for each question on the pre-treatment survey. A significant difference at the 1% level was found between the two groups for question 5 -- prior computer knowledge. No significant differences were found on any of the other questions. The *t* test performed on the post-treatment survey indicated no significant differences on any of the questions.

The two questions relating to effort were worded differently on the surveys and are listed in figure 3. On the pretreatment survey the means for both groups were nearly identical with no significant difference. Both questions indicated the experimental group felt they spent significantly more time and effort on aural skills than the control group. The results for both questions are listed below in Table 2.

Pre Prior to this class, how much have you worked on developing your ear ?
Post How much have you worked on developing your ear this semester?

Pre How often do you expect to practice ear training outside of class this semester?
Post How often did you practice ear training outside of class this semester?

Figure 3. Effort questions: pre-treatment and post-treatment surveys

Table 2
t Test between Post-treatment time and effort questions

	Mean Diff	SD Diff	T	DF	*p*
Question 8	0.667	0.840	3.367	17	0.004*
Question 9	0.735	1.200	2.525	16	0.022**

* indicates significance at 1% level ** indicates significance at 5% level

One final question was administered to both groups on the post-treatment survey only: How much of your improvement do you attribute to using the computer? A *t* test comparing the two groups found that the experimental group attributed significantly more of their improvement to the use of the computer. The results are shown in Table 3 and indicate significance at the 1% level.

Table 3
t test on computer effect

	Mean Diff	SD Diff	T	DF	*p*
Question 10	1.176	1.639	2.960	16	0.009*

* indicates significance at 1% level

A number of correlations were performed using data from the posttest and audit trail as coefficients to determine whether a relationship exists between progress and mode of instruction, time spent per section, time spent per session, number of sessions and number of replays per exercise. No significant correlation could be found between these aspects.

A correlation was performed between the number of levels attempted in the program and the final ear training examination score. Table 4 shows this relationship to be significant at the 5% level.

Table 4
Correlation of Exam Score and Levels Attempted

	Final Exam		Levels	
Final Exam	1.000			
Levels	0.580	1.000		
Bartlett Chi-Square Statistic:	4.314	DF=	1	PROB= 0.038

Comparisons of the students scores in the program drills and the posttest scores were used to determine how strong the link was between computer-assisted instruction program and the music theory curriculum and to determine if progress in the computer program could be used to predict success in the music theory examinations. The correlation shown in Table 5 shows the relationship to be significant at the 5 % level.

Table 5
Correlation of Exam Score and Average Drill Score

	Final Exam		Avg Score	
Final Exam	1.000			
Avg, Score	0.617	1.000		
Bartlett Chi-Square Statistic:	5.031	DF=	1	PROB= 0.025

Conclusions

The following conclusions are based on the results of the study. Any generalizations are limited to the freshman theory program at the University of Northern Colorado and the software used in the study.

The results indicate that curriculum-specific, computer-based training can be used as the primary method for the acquisition of aural skills. Students using the computer-assisted instruction exclusively developed slightly higher levels of aural skills than did students who used traditional methods, however the difference was insignificant. The grade distribution of the final exam indicated 50% of the experimental group received a B or better (37.5% received an A), compared with 40% of the control group (15% received an A).

No significant differences were found when comparing the overall final grades of the two groups, nor was there any difference in the gap between the final grades and the ear training final. As such, there is no indication that any benefits were derived from the additional time made available to the experimental group by the

exclusion of in-class dictation drill. Possible reasons for this are that the study did not control for instructor effect and that the written skills of the students were not statistically equated. Half of the experimental group was repeating the class, identifying them as possible low-achievers. Nonetheless, it ishould be noted that the instructor of the experimental group felt the method allowed him the flexibility to spend extra time on topics when necessary.

A primary benefit of the use of curriculum-based aural skills software is its efficiency and individualization of instruction. The decrease in the variance from pretest to posttest for the experimental group indicates the computer program provided more consistent instruction. This is all the more interesting considering the number of remedial students included in the group. It also appears to confirm the effectiveness of providing learner control with advisement. Students were allowed to choose the content, level and type of instruction and it would appear that most students made wise choices.

No change in attitude towards ear training resulted from the use of the software. Student attitudes remained positive in both groups; possibly a reflection of the overall success achieved. Both groups were also convinced of the relevance of aural skills training. Attitudes towards the use of computer-assisted instruction remained constant as well, even though students in the experimental group believed the software was effective and that its use was responsible for most of their improvement, while students in the control group felt their use of commercial software had little effect on their abilities. The experimental group was also more optimistic about their chances on the final examination, even though the control group was slightly more accurate in their predictions.

Keller suggested four factors--maintenance of attention, relevance of the material, student confidence and student satisfaction--are required to provide motivation (cited in Alessi, 1991). Coupled with the course requirement to use the program, this appears to be have been effective. Students in both music theory classes appeared to be reasonably motivated students, and indicated they expected to spend approximately the same amount of time outside of class working on aural skills. However, students in the experimental group felt they spent significantly more time outside of class than the control group and averaged just over 80 minutes per week using the program.

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